EXHIBIT G

Reissue
Due 6/2/95

APPLICATION FOR LETTERS PATENT

BY

GARY KARLIN MICHELSON, M.D.

FOR

THREADED FRUSTO-CONICAL INTERBODY

SPINAL FUSION IMPLANTS

CERTIFICATE OF EXPRESS MAILING

"Express Mail"
Mailing Label No. EG US

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated above and is addressed to:

PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231.

Date of Deposit: _____

Signed: _____

Typed or
Printed Name: _____

Date: _____

BACKGROUND OF THE INVENTION

Related Applications

This application is a continuation in part of copending United States application Serial No. 08/396,414 filed on February 27, 1995 which is a continuation-in-part of United States application Serial No. 08/074,781 filed on June 10, 1993, which is a continuation in part of United States application Serial No. 07/698,674 filed on May 10, 1991 which is a divisional of application Serial No. 07/205,935 filed on June 13, 1988, now United States Patent No. 5,015,247 all of which are incorporated herein by reference.

This application is also a continuation-in-part of United States application Serial No. 08/390,131 entitled Interbody Spinal Fusion Implants filed on February 17, 1995. This application is also a continuation in part of design patent Application Serial No. 29/023,623 entitled Spinal Distractor filed on October 3, 1994.

Field of the Invention

[REDACTED]

The present invention relates generally to interbody spinal fusion implants, and in particular to spinal fusion implants configured to restore and maintain two adjacent vertebrae of the spine in anatomical lordosis.

Description of The Related Art

Interbody spinal fusion refers to the method of achieving bony bridging between adjacent vertebrae through the disc space, the space between adjacent vertebrae normally occupied by a spinal disc. Numerous implants to facilitate such a fusion have been described by Cloward, Brantigan, Michelson, and others, and are known to those skilled in the art. Generally, cylindrical implants offer the advantage of conforming to an easily prepared recipient bore spanning the disc space and penetrating into each of the adjacent vertebrae. Such a bore may be created by use of a drill. It is an anatomical fact that both the cervical spine and the lumbar spine are normally lordotic, that is convex forward. Such

alignment is important to the proper functioning of the spine. Commonly, those conditions which require treatment by spinal fusion are associated with a loss of lordosis.

Michelson, in U.S. Patent Application Serial No. 08/396,414, entitled APPARATUS AND METHOD OF INSERTING SPINAL IMPLANTS, teaches a method for restoring the anatomical lordosis of the spine while performing the interbody fusion procedure.

[REDACTED]

Therefore, there exists a need for spinal fusion implants and instrumentation that permits for the uniform depth of bone removal from each of the adjacent vertebrae while restoring anatomical lordosis.

SUMMARY OF THE INVENTION

The present invention is directed to a variety of interbody spinal fusion implants having at least a partially frusto-conical configuration and the instrumentation and methods by which the implants of the present invention can be utilized to achieve a desired anatomical lordosis of the spine.

In the preferred embodiment, the spinal fusion implants of the present invention have an outer locus in which at least some of the points of the implant comprise a partially or fully frusto-conical shape substantially along the portion of the implant in contact with the adjacent vertebrae of the spine and have an insertion end and a trailing end. The spinal fusion implants of the present invention may be further modified so that while the upper and lower surfaces are portions of a frusto-cone, at least one side portion may be truncated to form a planar surface that is parallel to the central longitudinal axis of the implant to form straight walls. These implants may have a more tapered aspect at the insertion end of the implant to facilitate insertion. The

spinal fusion implants of the present invention may be relatively solid and/or porous and/or hollow, and may have surface roughenings to promote bone ingrowth and stability.

The spinal fusion implants of the present invention may have wells extending into the material of the implant from the surface for the purpose of holding fusion promoting materials and to provide for areas of bone ingrowth fixation. These wells, or holes, may pass either into or through the implant and may or may not intersect. The spinal fusion implants of the present invention may have at least one chamber which may be in communication through at least one opening to the surface of the implant. Said chamber may have at least one access opening for loading the chamber with fusion promoting substances. The access opening may be capable of being closed with a cap or similar means. Still further, a variety of surface irregularities may be employed to increase implant stability and implant surface area, and/or for the purpose of advancing the spinal fusion implant into the fusion site such as a thread. The exterior of the spinal fusion implant of the present invention may have wholly or in part, a rough finish, knurling, forward facing ratchetings, threads or other surface irregularities sufficient to achieve the purpose described.

The spinal fusion implants of the present invention offer significant advantages over the prior art implants:

1. Because the spinal fusion implants of the present invention are at least partially frusto-conical in shape, those that taper from the leading edge to the trailing edge, they are easy to introduce and easy to fully insert into the spinal segment to be fused. In the preferred embodiment, where the trailing edge of the implant is larger than the leading edge, the implant utilizes a tapered forward portion and an increasing thread height relative to the body from the leading edge to the trailing edge to facilitate insertion.

2. The shape of the implants of the present invention is

consistent with the shape of the disc, which the implants at least in part replace, wherein the front of the disc is normally taller than the back of the disc, which allows for normal lordosis. The implants of the present invention are similarly taller anteriorly than they are posteriorly.

3. The spinal fusion implants of the present invention allow for a minimal and uniform removal of bone from the vertebrae adjacent the disc space while still providing for an interbody fusion in lordosis when properly inserted.

4. The spinal fusion implants of the present invention conform to a geometric shape, which shape is readily producible at the site of fusion, to receive said spinal fusion implants.

The spinal fusion implants of the present invention can be made of any material appropriate for human implantation and having the mechanical properties sufficient to be utilized for the intended purpose of spinal fusion, including various metals such as cobalt chrome, stainless steel or titanium including its alloys, various plastics including those which are bio-absorbable, and various ceramics or combination sufficient for the intended purpose. Further, the spinal fusion implants of the present invention may be made of a solid material, a mesh-like material, a porous material and/or may comprise, wholly or in part, materials capable of directly participating in the spinal fusion process, or be loaded with, composed of, treated or coated with chemical substances such as bone, morphogenic proteins, hydroxyapatite in any of its forms, and osteogenic proteins, to make them bioactive for the purpose of stimulating spinal fusion. The implants of the present invention may be wholly or in part bioabsorbable.

OBJECTS OF THE PRESENT INVENTION

It is an object of the present invention to provide a

spinal fusion implant that is easily inserted into the spine, having a tapered leading end;

It is another object of the present invention to provide a spinal fusion implant that tapers in height from one end to the other consistent with the taper of a normal spinal disc;

It is yet another object of the present invention to provide a spinal fusion implant that is capable of maintaining anatomic alignment and lordosis of two adjacent vertebrae during the spinal fusion process;

It is still another object of the present invention to provide a spinal fusion implant that is self stabilizing within the spine;

It is yet another object of the present invention to provide a spinal fusion implant that is capable of providing stability between adjacent vertebrae when inserted;

It is still another object of the present invention to provide a spinal fusion implant that is capable of participating in the fusion process by containing, being composed of, or being treated with fusion promoting substances;

It is further another object of the present invention to provide a spinal fusion implant that is capable of spacing apart and supporting adjacent vertebrae during the spinal fusion process;

It is still further another object of the present invention to provide a spinal fusion implant that is consistent in use with the preservation of a uniform thickness of the subchondral vertebral bone;

It is another object of the present invention to provide a spinal fusion implant having a shape which conforms to an easily produced complementary bore at the fusion site; and

It is a further object of the present invention to provide a frusto-conical spinal fusion implant which may be placed side by side adjacent to a second identical implant across the same disc space, such that the combined width of the two implants is less than sum of the individual heights of each implant.

These and other objects of the present invention will

become apparent from a review of the accompanying drawings and the detailed description of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side elevational view of the spinal fusion implant of the present invention having a body that is frusto-conical with an external thread having a substantially uniform radius.

Figure 1A is an enlarged fragmentary view along line 1A of Figure 1 illustrating the surface configuration of the implant of Figure 1.

Figure 2 is a side elevational view of an alternative embodiment of the spinal fusion implant of the present invention having a frusto-conical body and an external thread that is frusto-conical where the thread height is constant but the thread radius varies.

Figure 3 is as cross sectional view along line 3--3 of the implant of Figure 3A.

Figure 3A is an alternative embodiment of the spinal fusion implant of the present invention having a frusto-conical body with an external thread radius and thread height that are not constant.

Figure 4 is a side elevational view of an alternative embodiment of the spinal fusion implant of the present invention having a frusto-conical body and a surface configuration comprising ratchetings for engaging bone, with wells and channels for bone ingrowth.

Figure 5 is a cross sectional view along line 5--5 of the implant of Figure 4 illustrating the channels and wells of the implant of the present invention.

Figure 6 is a cross sectional view along line 6--6 of the implant of Figure 4 illustrating the channels and wells of the implant of the present invention.

Figure 6A is a side elevational view of an alternative embodiment of the spinal fusion implant of the present invention

having truncated sides forming a planar surface parallel to the longitudinal axis of the implant and ratchetings having a radius and height that are not constant.

Figure 6B is a top plan view of the spinal fusion implant shown in Figure 6A.

Figure 7 is a side elevational view of an alternative embodiment of the spinal fusion implant of the present invention having a body that is made out of a fibrous mesh-like material that is partially frusto-conical with one side that is truncated shown next to an identical second implant illustrated in hidden line.

Figure 8 is sectional view along line 8--8 of the implants of Figure 7.

Figure 9A is an enlarged fragmentary view along line 9 of Figure 7 illustrating the surface configuration of the implant of Figure 7.

Figure 9B is an enlarged fragmentary view along line 9 of Figure 7 illustrating an alternative embodiment of the surface configuration of the implant of the present invention made of a cancellous material.

Figure 9C is a cross sectional view along lines 9C--9C of Figure 9B illustrating the alternative embodiment of the surface configuration of the implant of the present invention made of a cancellous material.

Figure 10 is a side elevational view in partial cut-away of an alternative embodiment of the spinal fusion implant of the present invention having a body that is frusto-conical and a surface configuration comprising a plurality of spaced apart posts.

Figure 11 is an enlarged fragmentary sectional view along lines 11--11 of Figure 10 illustrating the surface configuration of the implant of Figure 11.

Figure 12 is a side elevational view of an alternative embodiment of the spinal fusion implant of the present invention.

Figure 13 is a side elevational view and partial cut-away of a segment of the spinal column in lordosis showing the spinal fusion implant of Figure 12 being implanted with a driving

instrument from the posterior approach to the spinal column.

Figure 14 is a side elevational view of an alternative embodiment of the spinal fusion implant of the present invention having a frusto-conical body and truncated sides.

Figure 15 is an end view along line 15--15 of the spinal fusion implant of Figure 14 shown placed beside a second identical implant shown in hidden line.

Figure 16 is a side elevational view of an alternative embodiment of the spinal fusion implant of the present invention having a body with an irregular configuration.

Figure 17 is a side elevational view of a segment of the spinal column partially in lordosis showing a first drill and a second drill used in the method of the present invention.

Figure 18 is a side elevational view of the spinal distractor instrument of the present invention.

Figure 19 is a top plan view of the spinal distractor instrument of Figure 18.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to Figure 1, a side elevational view of the spinal fusion implant of the present invention generally referred to by numeral 20 is shown. The implant 20 has a body 22 that is frusto-conical in shape such that the body 22 has a diameter (root diameter) that is generally frusto-conical. The body 22 has an insertion end 24 and a trailing end 26. The insertion end 24 may include a tapered portion 25 to facilitate insertion of the spinal implant 20. In the preferred embodiment, when the implant 20 is inserted from the anterior aspect of the spine, the body 22 of the implant 20 has a maximum diameter at a point nearest to the trailing end 26 and a minimum diameter at a point nearest to the insertion end 24.

The implant 20 has an external thread 28 having a substantially uniform radius R_1 measured from the central longitudinal axis L_1 of the implant 20. The outer locus of the external thread 28 (major diameter) has an overall configuration

that is substantially parallel to the longitudinal axis L_1. While the major diameter of the implant 20 is substantially uniform, the external thread 28 may be modified at the leading edge by having initially a reduced thread radius to facilitate insertion of the implant 20 and may also be modified to make the external thread 28 self-tapping. In the preferred embodiment, the external thread 28 has a first thread 30 of a lesser radius than the radius R_1 of the remainder of the external thread 28 to facilitate insertion of the implant 20. The second thread 32 has a greater radius than the first thread 30, but is still shorter than the radius R_1 of the remainder of the external thread 28 which is thereafter of constant radius.

The body 22 is frusto-conical substantially along the portion of the body 22 in contact with the adjacent vertebrae of the spine which allows for the creating and maintaining of the adjacent vertebrae of the spine in the appropriate angular relationship to each other in order to preserve and/or restore the normal anatomic lordosis of the spine. The substantially uniform radius R_1 of the external thread 28 of the implant 20 allows for the engaging of the bone of the adjacent vertebrae in a position that counters the forces which tend to urge the implant 20 from between the adjacent vertebrae in the direction opposite to which the implant 20 was implanted. The greater thread height measured from the body 22 near the leading end 24 of the implant 20 provides greater purchase into the vertebral bone and again enhances the stability of the implant 20. Further, the configuration of the external thread 28 increases the surface area of the implant 20 in contact with the vertebrae to promote bone ingrowth.

The implant 20 has a recessed slot 34 at its trailing end 26 for receiving and engaging insertion instrumentation for inserting the implant 20. The recessed slot 34 has a threaded opening 36 for threadably attaching the implant 20 to instrumentation used for inserting the implant 20.

Referring to Figure 1A, the implant 20 has an outer surface 38 that is porous to present an irregular surface to the

bone to promote bone ingrowth. The outer surface 38 is also able to hold fusion promoting materials and provides for an increased surface area to engage the bone in the fusion process and to provide further stability. It is appreciated that the outer surface 38, and/or the entire implant 20, may comprise any other porous material or roughened surface sufficient to hold fusion promoting substances and/or allow for bone ingrowth and/or engage the bone during the fusion process. The implant 20 may be further coated with bioactive fusion promoting substances including, but not limited to, hydroxyapatite compounds, osteogenic proteins and bone morphogenic proteins. The implant 20 is shown as being solid, however it is appreciated that it can be made to be substantially hollow or hollow in part.

In the preferred embodiment, for use in the lumbar spine, the implant 20 has an overall length in the range of approximately 24 mm to 32 mm with 26 mm being the preferred length. The body 22 of the implant 20 has a root diameter at the insertion end 24 in the range of 8-20 mm, with 14-16 mm being the preferred root diameter at the insertion end, and a root diameter at the trailing end 26 in the range of 10-24 mm, with 16-18 mm being the preferred diameter at the trailing end 26, when said implants are used in pairs. When used singly in the lumbar spine, the preferred diameters would be larger.

In the preferred embodiment, the implant 20 has a thread radius R_1 in the range of 6 mm to 12 mm, with 9-10 mm being the preferred radius R_1. For use in the cervical spine, the implant 20 has an overall length in the range of approximately 10-22 mm, with 12-14 mm being the preferred length. The body 22 of the implant 20 has a root diameter at the insertion end 24 in the range of 8-22 mm, with 16-18 mm being the preferred root diameter at the insertion end when used singly, and 8-10 mm when used in pairs. The body 22 of the implant 20 has a root diameter at the trailing end 26 in the range of 10-24 mm, with 18-20 mm being the preferred root diameter at the trailing end 26 when used singly, and 10-12 mm when used in pairs; a thread radius R_1 in the range of

approximately 4-12 mm, with 9-10 mm being the preferred radius R_1 when inserted singularly and 5-7 mm when inserted side by side in pairs.

Referring to Figure 2, an alternative embodiment of the spinal fusion implant of the present invention is shown and generally referred to by the numeral 120. The implant 120 has a body 122 that is frusto-conical substantially along the portion of the body 22 in contact with the adjacent vertebrae of the spine similar to body 22 of implant 20, and has an insertion end 124 a tapered portion 125, and a trailing end 126. The implant 120 has an external thread 128 having a radius R_2 measured from the central longitudinal axis L_2 is not constant. The thread height of the external thread 128 that is constant with respect to the body 122 and parallels the body 122 such that the external thread 128 is also generally frusto-conical in shape. The implant 120 has an outer surface with large openings 140 and small openings 142 permitting bone ingrowth into the implant 120. H INSERT (A) FROM P. 13

Referring to Figure 3, a cross sectional view along line 3--3 of the implant 120 is shown. The implant 120 has an outer wall 144 surrounding an internal chamber 146. The large and small openings 140 and 142 may pass through the outer wall 144 to communicate with the internal chamber 146. The internal chamber 146 may be filled with bone material or any natural or artificial bone growth material or fusion promoting material such that bone growth occurs from the vertebrae through the openings 140 and 142 to the material within internal chamber 146. While the openings 140 and 142 have been shown in the drawings as being circular, it is appreciated that the openings 140 and 142 may have any shape, size configuration or distribution, suitable for use in a spinal fusion implant without departing from the scope of the present invention.

The implant 120 has a cap 148 with a thread 150 that threadably attaches to the insertion end 124 of the spinal fusion implant 120. The cap 148 is removable to provide access to the internal chamber 146, such that the internal chamber 146 can be

filled and hold any natural or artificial osteoconductive, osteoinductive, osteogenic, or other fusion enhancing material. Some examples of such materials are bone harvested from the patient, or bone growth inducing material such as, but not limited to, hydroxyapatite, hydroxyapatite tricalcium phosphate; or bone morphogenic protein. The cap 148 and/or the spinal fusion implant 120 may be made of any material appropriate for human implantation including metals such as cobalt chrome, stainless steel, titanium, plastics, ceramics, composites and/or may be made of, and/or filled, and/or coated with a bone ingrowth inducing material such as, but not limited to, hydroxyapatite or hydroxyapatite tricalcium phosphate or any other osteoconductive, osteoinductive, osteogenic, or other fusion enhancing material. The cap 148 and the implant 120 may be partially or wholly bioabsorbable.

Referring to Figure 3A, an alternative embodiment of implant 120 is shown and generally referred to by the numeral 120'. The implant 120' has a body 122' similar to body 122 of implant 120 and has an external thread 128' having a radius R_3 measured from the central longitudinal axis L_3 of the implant 120'. The thread radius R_3 is not constant throughout the length of the implant 120' and the external thread 128' has a thread height that is also not constant with respect to the body 122' of the implant 120'. In the preferred embodiment, the implant 120' has an external thread 128' with a radius R_3 that increases in size from the insertion end 124' to the trailing end 126' of the implant 120'.

~~Referring to Figure 4, an alternative embodiment of the~~ spinal fusion implant of the present invention is shown and generally referred to by the numeral 220. The implant 220 has a frusto-conical body 222 and an outer locus that is generally frusto-conical substantially along the portion of the implant 220 that is in contact with the adjacent vertebrae of the spine. The implant 220 has a surface configuration of forward facing ratchetings 240 suitable for engaging the bone of the adjacent vertebrae. Each of the plurality of ratchetings 240 has a bone engaging edge 242 and ramped portion 244. The ratchetings 240 have

a radius R_4 measured from the central longitudinal axis L_4 of the implant 220 that increases from the insertion end 224 to the trailing end 226. The height of the ratchetings 240 measured from the body 222 is constant throughout the length of implant 220.

The orientation of the ratchetings 240 makes the insertion of the implant 220 easier than its removal, as the ramped portions 244 act as an inclined plane on the way in, while the bone engaging edges 242 resist motion in the opposite directions. These forward facing ratchetings 240 tend to urge the implant 220 forward until the unremoved bone of the vertebrae blocks further motion resulting in a very stable spine and implant construct.

In the preferred embodiment, the bone engaging edges 242 of the ratchetings 240 have a height at a highest point measured from the body 222 (root diameter) of the implant 220 in the range of 0.25 - 2.0 mm, with the preferred height being 0.4 mm for use in the cervical spine and 1.25 mm for use in the lumbar spine.

Referring to Figures 5 and 6, cross sectional views of implant 220 are shown. The implant 220 has channels 250 passing through the implant 220 and wells 260 formed in the surface of the implant 220. The wells 260 may or may not communicate with the channels 250. In the preferred embodiment of implant 220, the channels 250 have a diameter in the range of 0.1 mm to 6 mm, with 2-3 mm being the preferred diameter. The wells 260 have a diameter in the range of 0.1 mm to 6 mm, with 1-3 mm being the preferred diameter range. It is appreciated that although the channels 250 and wells 260 are shown having a generally rounded configuration, it is within the scope of the present invention that the channels 250 and wells 260 may have any size, shape, configuration, and distribution suitable for the intended purpose.

Referring to Figures 6A and 6B, an alternative embodiment of the implant 220 is shown and generally referred to by the numeral 220'. The implant 220' is similar in configuration to implant 220 and has ratchetings 240' having a radius R_5 measured from the longitudinal central axis L_5 that increases in size from the insertion end 224' to the trailing end 226'. The ratchetings

240' each have a height measured from the body 222' that is not constant throughout the length of the implant 220'. In the preferred embodiment, the ratchet radius R_5 and the ratchet height increase in size from the insertion end 224' to the trailing end 226'.

As shown in Figure 6B, the implant 220' has truncated sides 270 and 272 forming two planar surfaces which are diametrically opposite and are parallel to the longitudinal axis L_4. In this manner, two implants 220' may be placed side by side with one of the sides 270 or 272 of each implant touching, such that the area of contact with the bone of the adjacent vertebrae and the ratchetings 240' is maximized. Alternatively, the implant 220' may have one truncated side.

Referring to Figures 7-9A, an alternative embodiment of the spinal fusion implant of the present invention is shown and generally referred to by the numeral 320a. The implant 320a is shown placed next to a second identical implant 320b shown in hidden line. The implant 320a has a body 322 that is made of a mesh-like material comprising strands, which may be made of metal, that are pressed together and molded into a partially frusto-conical configuration substantially along the portion of the implant 320a in contact with the adjacent vertebrae of the spine. The implant 320a has an insertion end 324 and a trailing end 326 and may be made wholly or in part of a solid material and/or a porous material, and/or a mesh-like material. The implant 320a may have a surface comprising of a porous material, a mesh-like material, or have a surface that is roughened. It is appreciated that the implant 320a may be solid or may be partially hollow and include at least one internal chamber. As shown in Figure 9A, the mesh-like material comprises strands that are formed and pressed together such that interstices 339, capable of retaining fusion promoting material and for allowing for bone ingrowth, are present between the strands in at least the outer surface 338 of implant 320a.

Referring to Figures 9B and 9C, alternatively the implant

320a may be made of a cancellous material 350, similar in configuration to human cancellous bone, having interstices 352 such that the outer surface 338 has a configuration as shown in Figures 9B and 9C. As the implant 320a may be made entirely or in part of the cancellous material 350, the interstices 352 may be present in the outer surface 338 and/or within the entire implant 320a to promote bone ingrowth and hold bone fusion promoting materials.

Referring again to Figure 8, the implant 320a is partially frusto-conical, similar in shape to implant 20 but having at least one truncated side 340 that forms a planar surface parallel to the central longitudinal axis of implant 320. The truncated side 340 allows for the placement of two implants 320a and 320b closer together when placed side by side between two adjacent vertebrae as set forth in U.S. Patent Application Serial No. 08/390,131, incorporated herein by reference. Implant 320a may be partially threaded or may otherwise resemble any of the other embodiments herein described or that are functionally equivalent.

Referring to Figure 10, a side elevational view in partial cut-away of an alternative embodiment of the implant of the present invention is shown and generally referred to by the numeral 420. The implant 420 has a body 422 that is frusto-conical in shape substantially along the portion of the implant 420 that is in contact with the adjacent vertebrae of the spine and has an insertion end 424 and a trailing end 426. The implant 420 has an outer surface 438 that is capable of receiving and holding bone, or other materials capable of participating in the fusion process and/or capable of promoting bone ingrowth. In the preferred embodiment, the surface 438 comprises a plurality of posts 440 that are spaced apart to provide a plurality of interstices 442 which are partial wells with incomplete walls capable of holding and retaining milled bone material or any artificial bone ingrowth promoting material. The implant 420 may be prepared for implantation by grouting or otherwise coating the surface 438 with the appropriate fusion promoting substances.

Referring to Figure 11, an enlarged view of the surface

438 of implant 420 is shown. In the preferred embodiment, the posts 440 have a head portion 444 of a larger diameter than the remainder of the posts 440, and each of the interstices 442 is the reverse configuration of the posts 444, having a bottom 446 that is wider than the entrance 448 to the interstices 442. Such a configuration of the posts 440 and interstices 442 aids in the retention of bone material in the surface 438 of the implant 420 and further assists in the locking of the implant 420 into the bone fusion mass created from the bone ingrowth. As the bone ingrowth at the bottom 466 of the interstices 442 is wider than the entrance 448, the bone ingrowth cannot exit from the entrance 448 and is locked within the interstice 442. The surface 438 of the implant 420 provides for an improvement in the available amount of surface area which may be still further increased by rough finishing, flocking or otherwise producing a non smooth surface.

In the preferred embodiment, the posts 440 have a maximum diameter in the range of approximately 0.1-2 mm and a height of approximately 0.1-2 mm and are spaced apart a distance of approximately 0.1-2 mm such that the interstices 442 have a width in the range of approximately 0.1 to 2 mm. The post sizes, shapes, and distributions may be varied within the same implant.

Referring to Figure 12, a side elevational view of an alternative embodiment of the spinal fusion implant of the present invention generally referred to by numeral 520 is shown. The implant 520 has a body 522 having a root diameter that is frusto-conical in the reverse direction as that of implant 20 shown in Figure 1, in order to preserve and/or restore lordosis in a segment of spinal column when inserted from the posterior aspect of the spine. The body 522 has an insertion end 524 and a trailing end 526. In the preferred embodiment, the body 522 of the implant 520 has a minimum diameter at a point nearest to the trailing end 526 and a maximum diameter at a point nearest to the insertion end 524. The insertion end 524 may have an anterior nose cone portion 530 presenting a tapered end to facilitate insertion.

The implant 520 has an external thread 528 having a